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(11)

**EP 0 900 940 B1**

(12)

**EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention  
of the grant of the patent:  
**07.01.2004 Bulletin 2004/02**

(51) Int Cl.7: **F04D 27/02, F04D 19/04**

(21) Application number: **98116576.4**

(22) Date of filing: **02.09.1998**

**(54) Method of operating a vacuum pump**

Betriebsverfahren einer Vakuumpumpe

Procédé d'opération d' une pompe à vide

(84) Designated Contracting States:  
**DE FR GB**

(30) Priority: **02.09.1997 JP 25283697**

(43) Date of publication of application:  
**10.03.1999 Bulletin 1999/10**

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- **PATENT ABSTRACTS OF JAPAN vol. 010, no. 037 (M-453), 14 February 1986 (1986-02-14) & JP 60 190696 A (SEIKO SEIKI KK), 28 September 1985 (1985-09-28)**

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## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention:

[0001] The present invention relates to a method of operating a vacuum pump, and more particularly to a method of operating a vacuum pump for use in an evacuating system for a semiconductor fabrication apparatus.

#### Description of the Related Art:

[0002] Vacuum pumps for use in evacuating systems for semiconductor fabrication apparatus generally do not have speed control means. Therefore, when such a vacuum pump starts to operate, it will subsequently continuously operate at a constant speed unless there is a reason to stop it. Even when an apparatus such as an semiconductor fabrication apparatus which is being evacuated by a vacuum pump stops its operation and no longer needs to be evacuated, the vacuum pump usually continues its operation. Reasons for continuously operating the vacuum pump even when it is not necessary to evacuate the semiconductor fabrication apparatus are as follows:

[0003] First, if the vacuum pump stopped, contaminants such as oil would flow back into the semiconductor fabrication apparatus that needs to be kept highly clean, and contaminate the semiconductor fabrication apparatus. Second, once the vacuum pump stopped, it would take a certain start-up time to operate the vacuum pump again for evacuating the semiconductor fabrication apparatus, resulting in a reduction in the throughput of the semiconductor fabrication apparatus. Third, various sublimated substances are generated in evaporation, sputtering, and CVD processes that are carried out by the semiconductor fabrication apparatus, and are constantly evacuated by the vacuum pump. If the vacuum pump stopped, those sublimated substances would be deposited in the vacuum pump and pipes connected thereto, possibly clogging the pipes or resulting in a failure to restart the vacuum pump.

[0004] For the above reasons, the conventional process of operating the vacuum pump suffers the following disadvantages:

[0005] Since the vacuum pump always operates at a constant speed, the vacuum pump wastes electric energy because it continues its operation even when the semiconductor fabrication apparatus does not need to be evacuated. Even during a time zone when the semiconductor fabrication apparatus is vented to the atmosphere and does not need to be evacuated, it is not preferable to stop operating the vacuum pump only in such a time zone.

[0006] DE 43 182 14A1 discloses a method for operating a vacuum pump with rotor rotational speeds which

are below the nominal speed. The speed of the rotor is continuously monitored. As soon as a rotational speed occurs which is located in a predetermined range of rotational speeds, a timer is started. In case the speed is still within the predetermined range of rotational speeds, after expiry of a predetermined time the rotational speed of the rotor is acted upon. This is done to avoid damages of the pump when operating with speeds of the rotor below the nominal speed.

[0007] In accordance with the present invention a method as set forth in claim 1 is provided. Preferred embodiments of the invention are disclosed in the dependent claims.

### SUMMARY OF THE INVENTION

[0008] It is therefore an object of the present invention to provide a method of operating a vacuum pump in a manner to reduce wasteful electric energy consumption and also to avoid drawbacks which would otherwise be caused if the vacuum pump stopped its operation.

[0009] According to the present invention, a method of operating a vacuum pump for use in an evacuating system for a semiconductor fabrication apparatus, comprises the step of reducing the rotational speed of the vacuum pump to an idling rotational speed in response to a signal from the semiconductor fabrication apparatus to be evacuated, thereby to lower electric energy consumption by the vacuum pump.

[0010] The vacuum pump may be actuated by a DC motor. The idling rotational speed of the vacuum pump may be adjustable.

[0011] According to the present invention, a method of operating a vacuum pump for use in an evacuating system for a semiconductor fabrication apparatus, comprises the steps of operating the vacuum pump at a steady rotational speed to evacuate the semiconductor fabrication apparatus, and reducing the rotational speed of the vacuum pump to an idling rotational speed in response to a signal indicative of an operating state of the semiconductor fabrication apparatus which does not need to be evacuated, thereby to lower electric energy consumption by the vacuum pump.

[0012] During a time zone in which the semiconductor fabrication apparatus does not need to be evacuated, the rotational speed of the vacuum pump to the idling rotational speed. Therefore, the electric energy consumption by the vacuum pump is lowered in the time zone. Furthermore, since the vacuum pump continuously evacuates the semiconductor fabrication apparatus at the idling rotational speed even during that time zone, oil or other contaminants are prevented from flowing back to the semiconductor fabrication apparatus, the throughput of the semiconductor fabrication apparatus is prevented from being undesirably lowered because the vacuum pump is not brought to a full stop, and the vacuum pump and pipes connected thereto are prevented from being clogged by sublimated substances which

would otherwise be deposited in the vacuum pump and the pipes if the vacuum pump were entirely stopped.

[0013] If the vacuum pump is actuated by the DC motor, then the rotational speed of the vacuum pump can easily be controlled simply by varying the DC voltage applied to the DC motor. Furthermore, if the idling rotational speed of the vacuum pump is adjustable, then since the operator of the semiconductor fabrication apparatus can set the idling rotational speed to a desired value, the idling rotational speed may be selected for a good balance between the electric energy consumption and various troubles caused if the vacuum pump were fully stopped.

[0014] The above and other objects, features, and advantages of the present invention will become apparent from the following description when taken in conjunction with the accompanying drawings which illustrate a preferred embodiment of the present invention by way of example.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

FIG. 1 is a block diagram of a vacuum pump operating system for carrying out a method of operating a vacuum pump according to the present invention; FIG. 2A is a graph showing the manner in which the amount of electric energy consumption by a vacuum pump operated by a conventional method varies; and

FIG. 2B is a graph showing the manner in which the amount of electric energy consumption by a vacuum pump operated by the method according to the present invention varies.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] As shown in FIG. 1, a vacuum pump operating system for carrying out a method of operating a vacuum pump according to the present invention has a vacuum chamber 11 which is to be evacuated, such as of a vacuum evaporation apparatus, a sputtering apparatus, or an ion implanter. The vacuum chamber 11 is connected through a valve 12 to a vacuum pipe 13 connected to a vacuum pump 14. The vacuum pump 14 has a DC motor 15 for operating the vacuum pump 14 to evacuate the vacuum chamber 11. Since the rotational speed of the DC motor 15 is linearly variable depending on the magnitude of a DC voltage applied to the DC motor 15, the rotational speed of the DC motor 15 can greatly be varied by varying the DC voltage applied to the DC motor 15.

[0017] The vacuum chamber 11 which is to be evacuated is associated with a rotational speed changing signal output unit 17. When a time zone in which the vacuum chamber 11 does not need to be evacuated is

reached, the rotational speed changing signal output unit 17 responds to an operating state of the vacuum chamber 11, and outputs a signal to lower the rotational speed of the vacuum pump 14 to the vacuum pump 14.

Therefore, when the vacuum chamber 11 is vented to the atmosphere and is no longer required to be evacuated, the rotational speed changing signal output unit 17 issues a signal indicative of an idling rotational speed to the vacuum pump 14 in response to the operating state of the vacuum chamber 11. In response to the supplied signal from the rotational speed changing signal output unit 17, the voltage applied to the DC motor 15 is varied to reduce the rotational speed of the vacuum pump 14 to the idling rotational speed.

[0018] FIG. 2A shows showing the manner in which the amount of electric energy consumption by a vacuum pump operated by a conventional method varies. According to the conventional method, as shown in FIG. 2A, after the vacuum pump has started to operate, the electric energy consumption by the vacuum pump remains constant with time. The electric energy consumption by the vacuum pump remains constant because the vacuum pump operates at a constant rotational speed even during a time zone in which the vacuum chamber does not need to be evacuated by the vacuum pump.

[0019] FIG. 2B shows the manner in which the amount of electric energy consumption by the vacuum pump 14 operated by the method according to the present invention varies. In the method according to the present invention, after the vacuum pump 14 has started to operate, the vacuum pump 14 operates in a steady state at a steady rotational speed to evacuate the vacuum chamber 11, and the electric energy consumption by the vacuum pump 14 remains constant in the steady state as with the conventional method. When the rotational speed changing signal output unit 17 issues a signal indicative of an idling rotational speed to the vacuum pump 14 at a time  $t_1$ , the voltage applied to the DC motor 15 is lowered to reduce the rotational speed of the vacuum pump 14 to the idling rotational speed. Therefore, the electric energy consumption by the vacuum pump 14 is reduced.

[0020] At a time  $t_2$  when the vacuum chamber 11 needs to be evacuated again, the rotational speed changing signal output unit 17 issues a signal indicative of the steady rotational speed to the vacuum pump 14 in response to the operating state of the vacuum chamber 11. The voltage applied to the DC motor 15 is now increased to a steady level, increasing the rotational speed of the vacuum pump 14 to the steady rotational speed. Thus, the electric energy consumption by the vacuum pump 14 is increased to the steady level.

[0021] In the method of controlling the vacuum pump 14 according to the present invention, the vacuum pump 14 is operated in an idling state during a time zone in which the vacuum chamber 11 does not need to be evacuated, and hence the electric energy consumption by the vacuum pump 14 is reduced in the idling state. If

the rotational speed of the vacuum pump 14 in the idling mode is adjustable, then the rotational speed of the vacuum pump 14 in the idling state may be set depending on the characteristics of the vacuum chamber to be evacuated, so that the vacuum pump 14 may provide a minimum evacuating capability that is required in the idling state.

[0022] Since the vacuum pump continuously evacuates the semiconductor fabrication apparatus at the idling rotational speed even during a time zone in which the semiconductor fabrication apparatus does not need to be evacuated, oil or other contaminants are prevented from flowing back to the semiconductor fabrication apparatus, the throughput of the semiconductor fabrication apparatus is prevented from being undesirably lowered because the vacuum pump is not brought to a full stop, and the vacuum pump and pipes connected thereto are prevented from being clogged by sublimated substances which would otherwise be deposited in the vacuum pump and the pipes if the vacuum pump were entirely stopped.

[0023] In the illustrated embodiment, the DC motor 15 is used to actuate the vacuum pump 14, and the rotational speed of the DC motor 15 is varied by varying the magnitude of the DC voltage applied to the DC motor 15. However, an AC induction motor with a built-in inverter may be used to actuate the vacuum pump 14, and the rotational speed of the AC induction motor may be varied.

[0024] In the illustrated embodiment, the rotational speed of the vacuum pump 14 is switched to the idling rotational speed in response to the operating state of the vacuum chamber 11 to be evacuated by the vacuum pump 14. However, the operator of the vacuum chamber 11 to be evacuated by the vacuum pump 14 may manually switch the rotational speed of the vacuum pump 14 to the idling rotational speed.

[0025] According to the present invention, since the electric energy consumption by the vacuum pump can be reduced, the vacuum pump can be operated with a reduced amount of electric energy. If the rotational speed of the vacuum pump lowered to the idling rotational speed in response to the operating state of the vacuum chamber to be evacuated by the vacuum pump, then the rotational speed can automatically be switched to the idling rotational speed without manual intervention for energy conservation. Furthermore, if the rotational speed of the vacuum pump variably controlled using the DC motor, then the overall mechanical arrangement is relatively simple because an external inverter and a mechanical speed control gear system are not required.

[0026] Although a certain preferred embodiment of the present invention has been shown and described in detail, it should be understood that various changes and modifications may be made therein without departing from the scope of the appended claims.

## Claims

1. A method of operating a vacuum pump (14) for use in an evacuating system for a semiconductor fabrication apparatus, comprising the steps of:

operating the vacuum pump at a steady rotational speed to evacuate the semiconductor fabrication apparatus; and  
reducing the rotational speed of the vacuum pump (14) to an idling rotational speed in response to a signal from the semiconductor fabrication apparatus to be evacuated, thereby to lower electric energy consumption by the vacuum pump.

2. A method according to claim 1, wherein said vacuum pump (14) is actuated by a DC motor.
3. A method according to claim 1, wherein said idling rotational speed of the vacuum pump is adjustable.
4. A method according to claim 1, wherein said signal is indicative of an operating state of the semiconductor fabrication apparatus which does not need to be evacuated.
5. A method according to claim 4, wherein said vacuum pump is actuated by a DC motor (15).
6. A method according to claim 4, wherein said idling rotational speed of the vacuum pump (14) is adjustable.

## Patentansprüche

1. Verfahren zum Betreiben einer Vakuumpumpe (14) zur Verwendung in einem Evakuiersystem für eine Halbleiterherstellungsvorrichtung, wobei das Verfahren die folgenden Schritte aufweist:

Betreiben der Vakuumpumpe mit einer stetigen Drehgeschwindigkeit bzw. Drehzahl zum Evakuieren der Halbleiterherstellungsvorrichtung; und  
Reduzieren der Drehzahl der Vakuumpumpe (14) auf eine Leerlaufdrehzahl ansprechend auf ein Signal von der zu evakuierenden Halbleiterherstellungsvorrichtung, um dadurch den elektrischen Energieverbrauch der Vakuumpumpe zu verringern.

2. Verfahren nach Anspruch 1, wobei die Vakuumpumpe (14) durch einen Gleichstrommotor betätigt wird.
3. Verfahren nach Anspruch 1, wobei die Leerlauf-

drehzahl der Vakuumpumpe einstellbar ist.

4. Verfahren nach Anspruch 1, wobei das Signal einen Betriebszustand der Halbleiterherstellungsvorrichtung anzeigt, in dem es nicht notwendig ist, sie zu evakuieren. 5
5. Verfahren nach Anspruch 4, wobei die Vakuumpumpe durch einen Gleichstrommotor (15) betätigt wird. 10
6. Verfahren nach Anspruch 4, wobei die Leerlaufdrehzahl der Vakuumpumpe (14) einstellbar ist.

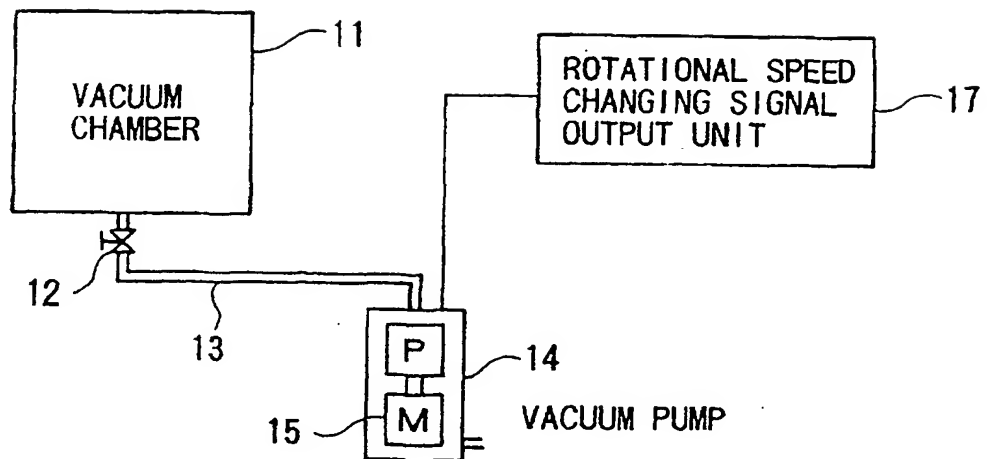
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### Revendications

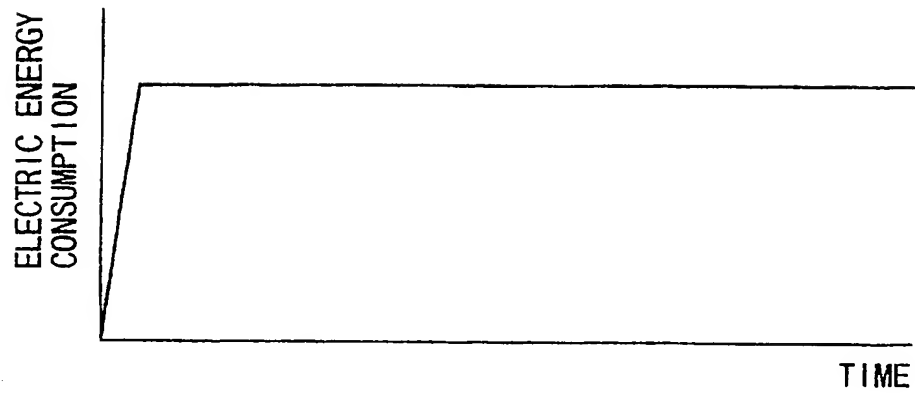
1. Procédé pour actionner une pompe à vide (14) destinée à être utilisée dans un système de vide pour un appareil de fabrication de semi-conducteurs, comprenant les étapes consistant à : 20  
  
actionner la pompe à vide à une vitesse de rotation constante afin de faire le vide dans l'appareil de fabrication de semi-conducteurs ; et 25  
réduire la vitesse de rotation de la pompe à vide (14) à une vitesse de rotation au ralenti en réponse à un signal provenant de l'appareil de fabrication de semi-conducteurs dans lequel le vide doit être fait, afin d'abaisser de ce fait la consommation d'énergie électrique de la pompe à vide. 30
2. Procédé selon la revendication 1, dans lequel ladite pompe à vide (14) est actionnée par un moteur à courant continu. 35
3. Procédé selon la revendication 1, dans lequel ladite vitesse de rotation au ralenti de la pompe à vide est réglable. 40
4. Procédé selon la revendication 1, dans lequel ledit signal est indicatif d'un état de fonctionnement de l'appareil de fabrication de semi-conducteurs dans lequel le vide n'a pas besoin d'être fait. 45
5. Procédé selon la revendication 4, dans lequel ladite pompe à vide est actionnée par un moteur à courant continu (15). 50
6. Procédé selon la revendication 4, dans lequel ladite vitesse de rotation au ralenti de la pompe à vide (14) est réglable.

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FIG. 1



*FIG. 2A*



*FIG. 2B*

